PATENT CLAIMS

1. Method for examining a sample by means of magnetic resonance spectroscopy including the execution of a utilization experiment comprising the following steps:

a substantially homogenous main magnetic field is generated in a measurement region containing the volume of the sample using a main field coil which encompasses the measurement region, which main field aligns the atomic spins of the sample longitudinally with respect to the field lines and has an amplitude progression in the form of at least one pulse which follows a defined time function within a defined time window;

from a point in time before or at the commencement of the defined time window the sample is subjected to a high frequency electromagnetic excitation pulse whose frequency band, amplitude and duration are selected such that within the time window a magnetic resonance signal appears;

the temporal progression of the magnetic resonance signal is measured and its spectrum is analysed.

2. Method as claimed in Claim 1, wherein the pulse of the main magnetic field is generated using a main field coil of resistive conductor material and an energy storage device which is charged before the experiment and then connected to the main field coil in order to generate in the coil a current which produces the main field pulse.

3. Method as claimed in Claim 2, wherein a capacitive energy storage device is used as the energy storage device.

4. Method as claimed in Claim 2, wherein at a point in time after the process of measuring the magnetic resonance signal an ohmic shunting resistor is connected in parallel with the main field coil, in such a manner that the strength of the main field dies away aperiodically from this point in time.

5. Method as claimed in Claim 1, wherein the defined time function is determined by means of a series of calibration experiments which are performed prior to the utilization experiment and wherein the strength of the main field is measured at different points in time along the time axis of the respectively generated main field pulse.

6. Method as claimed in Claim 5, wherein a recalibration of the determined time function is performed by the following steps:

a calibration test piece which comprises a spin type with a known gyromagnetic ratio is subjected to a constant main field with a known field strength and the operating parameters for obtaining a satisfactory magnetic resonance signal from the known spin type are sought;

subsequently experiments using the calibration test piece are performed in a pulsed main field for which the time function has been determined, wherein, by manipulation of at least one of the operating parameters found at a constant main field, the point on the field progression is sought at which a satisfactory magnetic resonance signal is generated from the known spin type;

in the event that the point found deviates from the determined time function, the determined time function is amended in the sense of a correction of the deviation.

7. Method as claimed in Claim 5, wherein a recalibration of the determined time function is performed by the following steps:

a calibration test piece which comprises a first spin type with a large gyromagnetic ratio γ_1 and a second spin type with a small gyromagnetic ratio γ_2 is subjected to a constant main field with a known field strength, and the operating parameters for obtaining a satisfactory magnetic resonance signal from the first spin type are sought;

subsequently experiments using the calibration test piece are performed in a pulsed main field for which the time function has been determined, wherein the amplitude of the

excitation pulse is increased according to the quotient γ_1/γ_2 and by further manipulation of the increased amplitude and/or of another of the operating parameters found at a constant main field, the point on the field progression is sought at which a satisfactory magnetic resonance signal is generated from the second spin type;

in the event that the point found deviates from the determined time function, the determined time function is amended in the sense of a correction of the deviation.

8. Method as claimed in Claim 7, wherein the two spin types are isotopes of the same chemical element.

9. Method as claimed in Claim 8, wherein the first spin type is normal hydrogen ^1H and the second spin type is heavy hydrogen ^2D.

10. Method as claimed in Claim 1, wherein the measured magnetic resonance signal is frequency modulated inverse to the defined time function.

11. Method as claimed in Claim 1, wherein the defined time window is positioned close to the maximum or in the region of the maximum of the main field pulse.

12. Method as claimed in Claim 11, wherein the spectrum of the magnetic resonance signal is calculated by means of a time-dependent Fourier transformation according to the said defined time function.

13. Method as claimed in Claim 1, wherein the rising portion of the main field pulse has a temporal progression which allows spins which are relaxing slowly sufficient time to become fully polarised until the point in time of the pulse maximum.

14. Method as claimed in Claim 13, wherein the main field pulse is generated in the form of two successive steps,

the first of which pre-polarizes the spins and has lower amplitude than the second step in which lies the defined time window.

15. Method as claimed in Claims 2 and 14, wherein the first step of the main field pulse is generated by connecting a separate energy source to the main field coil and wherein the second step is generated by discharging the energy storage device across the main field coil.

16. Method as claimed in any one of Claims 1 to 15, wherein prior to performing utilization experiments the time functions for several main field pulses of differing peak amplitudes are determined and stored,
and wherein during the performance of a utilization experiment the temporal progression of the main field is measured before the excitation pulse is generated,
and wherein by comparing the measurement result with the stored time functions prior to generating the excitation pulse, the stored time function which is closest to the measurement result is selected as the defined time function for the utilization experiment.

17. Apparatus for examining a sample by means of magnetic resonance spectroscopy comprising:
a main field coil for generating a substantially homogenous main magnetic field in a measurement region;
a sample holder for holding the sample in the measurement region;
a current pulse generator for operating the main field coil by a current pulse in order to generate in the measurement region at least one main field pulse which can align atomic spins of the held sample longitudinally with respect to the field lines and which follows a defined time function within a defined time window;
a sample coil encompassing the site of the sample;
an HF generator for influencing the sample coil with an electromagnetic HF oscillation pulse whose frequency band,

amplitude and duration are adjustable to such an extent that within the defined time window a magnetic resonance signal from the sample is induced in the sample coil;

a detection device for detecting the induced magnetic resonance signal;

a control device, which can be programmed to trigger the current pulse, to trigger the HF pulse and to connect the detection device to the sample coil for the duration of the defined time window.

18. Apparatus as claimed in Claim 17, wherein the main field coil consists of resistive conductor material.

19. Apparatus as claimed in Claim 17, wherein the current pulse generator comprises an energy storage device which can be connected, after it is charged, to the main field coil in order to allow a current, which produces the main field pulse, to flow in the main field coil.

20. Apparatus as claimed in Claim 19, wherein the energy storage device is a capacitive energy storage device.

21. Apparatus as claimed in Claim 19 or 20, wherein a shunting resistor is arranged in parallel with the main field coil in series with a switch.

22. Apparatus as claimed in Claim 17, further comprising a Fourier calculator for performing a Fourier transformation of the detected magnetic resonance signal.

23. Apparatus as claimed in Claim 22, wherein the Fourier calculator is designed in such a manner that the Fourier transformation is performed in a time-dependent manner according to the defined time function.

24. Apparatus as claimed in Claim 17, further comprising:

a frequency modulator for performing frequency modulation

of the detected magnetic resonance signal inversely with respect to the defined time function

and a Fourier calculator for performing the Fourier transformation of the frequency modulated magnetic resonance signal.

25. Apparatus as claimed in Claim 17, wherein the defined time window lies close to the maximum or in the range of the maximum of the main field pulse.

26. Apparatus as claimed in Claim 17, wherein the current pulse generator is designed to generate the main field pulse with a temporal progression which allows spins which are relaxing slowly sufficient time to become fully polarized until the point in time of the pulse maximum.

27. Apparatus as claimed in Claim 26, wherein the current pulse generator is designed to generate the main field pulse in the form of two sequential steps, the first of which pre-polarizes the spins and has a lower amplitude than the second step in which the defined time window lies.

28. Apparatus as claimed in Claims 19 and 27, wherein the current pulse generator comprises a separate energy source to generate the first step of the main field pulse.

29. Sample head which is tailored for use in an apparatus as claimed in any one of Claims 17 to 28, in that it comprises the sample coil which is rigidly connected mechanically to a vessel for receiving the sample and rigidly connected mechanically to an electric connector for connection to an HF supply line.

30. Sample head as claimed in Claim 29, further comprising a capacitor and an inductivity element which form together with the sample coil a resonance circuit with a preselected resonance frequency.

31. Sample head as claimed in Claim 30, wherein the resonance frequency and the quality factor of the resonance circuit formed are set in such a manner that the magnetic resonance to be analysed of the sample to be used at main field strengths, which occur within the defined time window, lies within the resonance bandwidth of the said resonance circuit.

32. Sample head as claimed in any one of Claims 29 to 31 with a sheathing which encompasses all parts of the sample head.